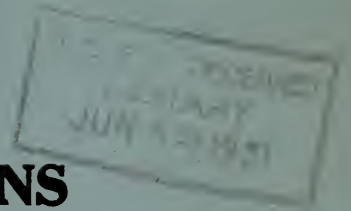


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**SPECIFICATIONS AND PLANS
FOR LOOKOUT TOWERS.**



**UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE**

W. B. Greeley, Forester.

TOWERS SECTION

DESIGNS FOR STEEL TOWERS

AND

INSTRUCTIONS FOR BUYING AND CONSTRUCTING

INSTRUCTIONS FOR PREPARING BIDS FOR STEEL TOWERS

Plates LX 24 and LX 25 illustrate two designs of steel towers of the following heights: 35 feet, 47 feet, 61 feet and 75 feet. The designs are identical excepting as to specifications of the ladder. Design LX 24 has its ladder fixed to the center of one of the tower's sides - common outside type of ladder. Design LX 25 has its ladder on the inside of the structure extending upward in a staggered fashion from platforms constructed on frames of angle iron which rest on the respective main horizontal girts.

Design LX 25 will be considerably more expensive than Design LX 24; first, because of its greater original cost; second, because of additional transportation charges due to the greater weight; and third, because of greater cost of erection.

The safety provided by the inside ladder may or may not be worth this additional cost. The question is one not susceptible of an exact answer. No recommendations are made. In reaching a decision as to the justification of buying the more expensive design purchasers should bear in mind that in twelve years of experience with outside ladders on steel-towers no lives have been lost and, as a matter of fact, no minor accidents resulting from the use of that type of ladder are of record.

How to Use the Specifications

The types of towers shown on the respective Designs LX 24 and LX 25 are satisfactory for the needs of the Forest Service.

It would be desirable to accompany invitations to bidders with drawings showing the type of tower desired. However, since the details of designs LX 24 and LX 25 were worked out very largely by the engineers of the Aermotor Company, and since the Aermotor Company imposes objection to advertising in the tower world little kinks of the trade originated and designed by its men, the feeling is that in fairness to the Aermotor Company its drawings should be used only in a semiconfidential way. Accordingly, excepting for bids which might go to the Aermotor Company, Designs LX 24 and LX 25 should be used only as models against which to check designs submitted by manufacturers other than the Aermotor Company in response to invitations to bid. Invitations to bidders other than the Aermotor Company should contain the specifications set forth in the sample bid included in this section of this circular. Invitations for bids to the Aermotor Company may simply ask for prices on towers of given heights, constructed in accordance with designs shown on Aermotor Company Plate No. LX 24 or LX 25, as the case may be. Bids to the Aermotor Company should also specify the type of anchor rods desired.

2

In comparing designs submitted by bidders with the specifications of Designs LX 24 or LX 25, accept none as satisfactory which have members of smaller cross-section dimensions for towers of respective heights (provided that for towers between 20 and 60 feet in height a full frame having corner members $3\frac{1}{2}" \times 3\frac{1}{2}" \times 5/8"$ may be accepted), or those whose system of bracing does not give equal or superior rigidity to the structure. (The style of bracing may not be identical but still be satisfactory.) Accept no design whose base measurements are less for towers of the various heights than those shown on the model plates. Accept no towers of designs having fewer bolts through joining members than are indicated in the model. On the other hand, do not accept towers of greater strength offered in bids if their cost is greater than the Aeromotor Company's bid for towers of equal height of Designs LX 24 or LX 25.

The styles of anchorage shown on Plates A and B are offered as suggestions only. Other designs may be equally as satisfactory, but in comparing designs from proposed bidders, check with the designs of A and B to determine whether or not the cross sections of the angle iron legs, if angle iron legs are used, are equal and, if anchor rods are proposed, see to it that such rods have cross-section dimensions equal to those of Plate B.

Erection of Steel Towers

Anchors

Anchors of type "B" are preferable in case towers are to be erected on situations where solid rock in place is encountered at or near the surface. When rock is so encountered holes should be drilled for the anchor rods. Correct positions for the holes can be determined by following the method suggested in Figure No. 1. Plate B anchor rods will be cemented in the holes with neat concrete, or with hot sulphur. Unevenness of ground can be rectified by the building up of small concrete piers to the proper level above the surface of the rock. One method of connecting the lower members of the tower to the anchor rods is shown in Figure 3, Plate B.

Anchors of type "A" illustrated on Plate A may be preferable to type "B" in case a tower is to be located where there is no probability of encountering rock in place. Type A footing members are made up of angles of the same size as the lower corner posts of the tower with a cross member of the same material at the base end. Footing blocks of this type are to be placed within a concrete or masonry block as indicated in Plate A.

Setting the Anchors


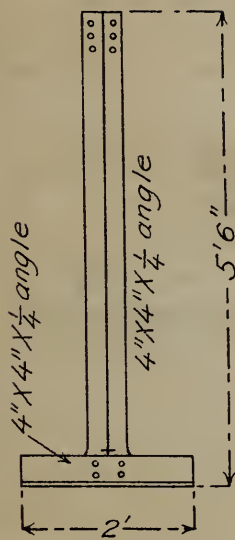
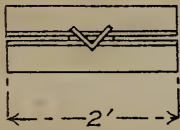
The anchors must be set absolutely square and the bolt  lies on all four corners in the anchors of type "A" must be absolutely level with respect to one another. The top of the piers in the type "B" anchor must be absolutely level with respect to one another. The top of the plates on the piers in the type "B" anchor must be absolutely level. If anchors are not made level as described the tower will go up in a twist.

Figure 1, Plate B, indicates one way of laying out the position for footing members.

Anchor Post



Footing Type B

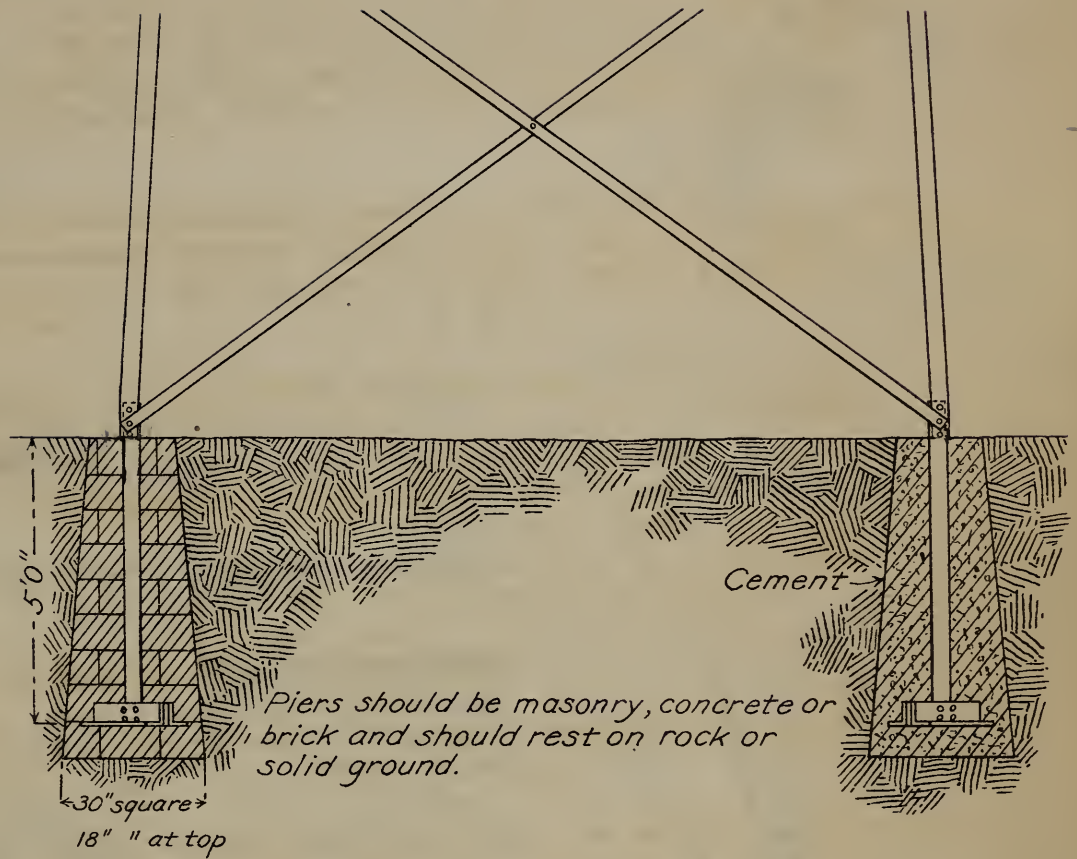
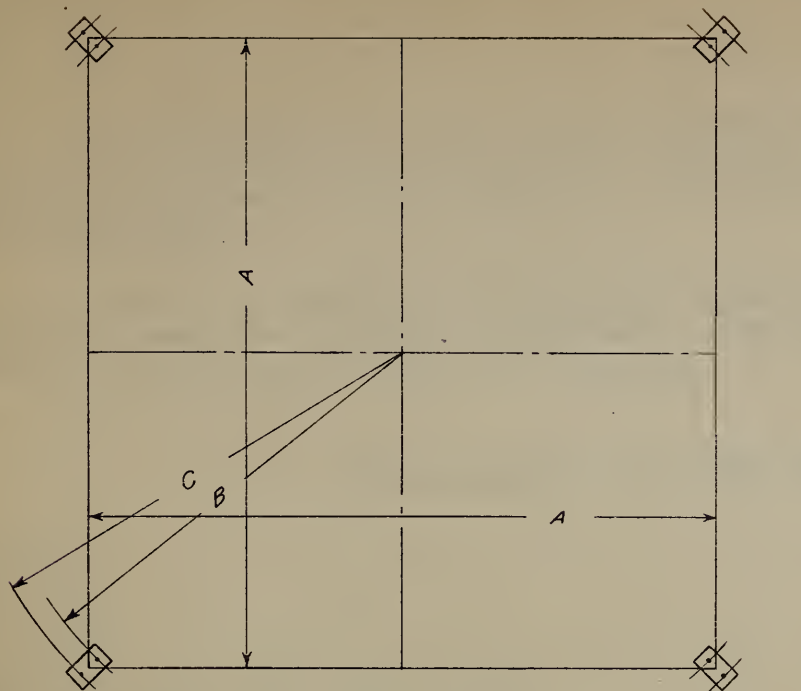


PLATE A.





SETTING OF ANCHOR RODS



Fig. 1.

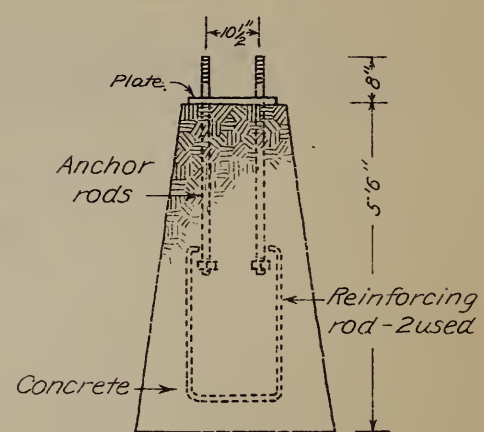
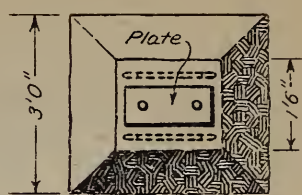


Fig. 2.
DETAIL OF PIER

TABLE OF DIMENSIONS

HEIGHT TOWER	A	B	C	D	E	F

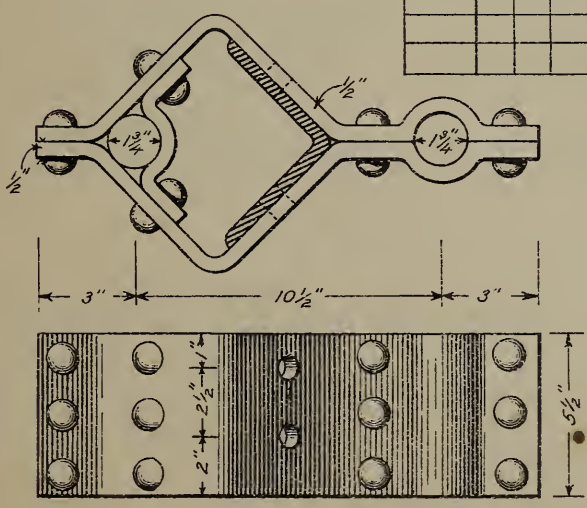
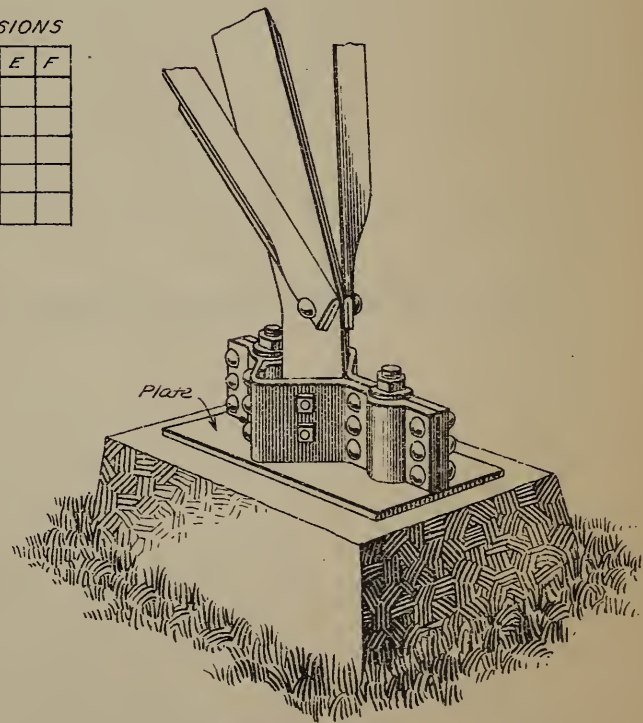


Fig. 4.
DETAIL OF FOOT CLAMP



PERSPECTIVE VIEW OF FOOT OF
TOWER, SHOWING METHOD OF
FASTENING TOWER TO FOUNDATION

Fig. 3.

In every purchase, manufacturers should be required to give for the different heights of towers the measurements needed to lay out footings in accordance with this system. (Refer to Item 6, page 9 of sample specifications.)

The man in charge of the erection should make certain that his spirit levels are in perfect adjustment. Similarly the correct alignment of his straight edges needs to be assured.

Tools Required on a Tower Job

(Picks
(Shovels
(Drills -
(Crowbar
(Hammers, etc., for digging holes
1 or 2 spirit levels, 30" to 36" long or more
1 or 2 straight edges of requisite length
1 carpenter square
1 hand saw
1 rip saw
1 carpenter brace
1 each, bits 3/8," 5/8," 3/4"
1 bit, expansive
1 - 1/8" plane
2 carpenter hammers
2 - 6" or 8" monkey wrenches
2 - 6" or 8" "S" wrenches
2 - 6" or 8" screwdrivers
100 feet heavy chalk line
3 long pointed punches tapered 3/8" to 4/8" - part 4" long, shank 12" long
1 trowel
1 hoe
1 putty knife
1 - 25-foot steel tape
200 feet 1/2" rope or 3/8" bell cord
1 single 1/2" block
Lumber for forms and mixing box
Barrels for water

Material Needed for Concrete Piers

$1\frac{1}{2}' \times 2\frac{1}{2}' \times 5'$

		Cement		S a n d		Gravel or crushed stone		Water	
Mixture	No. sacks	Cu. ft.	Weight	Cu. ft.	Weight	Cu. ft.	Weight	Gal.	Weight
1:2:4	17	33	3600	66	7600	110	900		

Lumber for Forms, Sawn or Split

The amount of gravel or crushed stone may be reduced to one-half or even to one-third of the amount given in the above tabulation if hard rock containing up to 100 cubic inches is available. If rock is used, do not use it above a point in the pier within 10 to 12 inches of the ground line. The section of the pier above that point should be of concrete of the mixture given in the preceding table. The position in which the rocks are placed in the pier is not important. Care should always be taken, however, to see to it that each rock is completely surrounded with a bed of concrete at least three inches thick. Rock should always be entirely free from dust and loose earth of any form. Preferably rock should be dipped in water before placement.

The concrete should be mixed to a "quaky" state, that is, it should contain just enough water to make it quaky or jellylike.

Sand should be coarse and free from dust or earth. Likewise, gravel or crushed stone should be clean.

Quantities shown above are generously calculated.

Cement and Sand Needed for Mortar if Masonry Piers are Used

$1\frac{1}{2}' \times 2\frac{1}{2}' \times 5'$

	:	1:2 mixture				:
	:	-----				:
Class of rock	:	Sack	:	Sand	:	Water
used	:	cement	:	Cu.ft. : Weight	:	Gal. : Weight
	:	-----				:
Mixed stones	:	15	:	30	:	45
6" to 14" wide:	:		:	3500	:	360
4 to 8" thick :	:		:		:	
with 3/4"	:		:		:	
joints	:		:		:	
	:		:		:	
Rough stones	:	9	:	17	:	35
10" to 12"	:		:	2000	:	280
wide 4" to 6"	:		:		:	
thick with	:		:		:	
3/4" joints	:		:		:	
	:		:		:	
Rough stones	:	5	:	12	:	20
16" to 18"	:		:	1400	:	160
wide, 6" to	:		:		:	
8" thick with	:		:		:	
3/4" joints	:		:		:	

Rock when laid should be free from dirt and dust, and wet if practicable. Mortar should be just wet enough to handle conveniently on a trowel.

Quantities shown above are generously calculated.

Amount of Mortar Required for Each Cubic Foot of Masonry

		Material needed to make:			
		one cubic foot of mortar			
		1:2 mixture			
Description	Cu. ft. mortar	Sacks of	Cubic ft.	Approximate no. of	
of	per cu. ft. of	cement	sand	gal. of water per	
rock	masonry			each cu. ft. of mortar	
Mixed stones	.35	1/2	.90	1 1/6	
6" to 14"					
wide 4" to					
8" thick					
with 3/4"					
joints					
Rough stones	.25	1/2	.90	1 1/6	
10" to 12"					
wide 4" to					
6" thick with					
3/4" joints					
Rough stones	.15	1/2	.90	1 1/6	
16" to 18"					
wide, 6" to					
8" thick					
with 3/4"					
joints					

Material Required for One Cubic Foot of Concrete

		Quantities of Material				Water	
Cement	S a n d	Crushed rock or					
Mixture	sacks	Cu. ft.	Lbs.	Cu. ft.	Lbs.	Gal.	Weight
1:2:4	.225	.44	58	.88	109	1 1/4	10

The two preceding tables may be useful in estimating quantities for footing blocks of varying dimensions.

Protection of Concrete after Placing

If best results are to be expected, new concrete should not be exposed to the sun for 5 or 6 days. During the "setting" earth or sand placed around and over the pier and kept wet will give needed protection. Canvas or burlap wetted once or twice daily and placed so as to hang an inch or so away from the new concrete will also serve very well. It is good practice to leave the forms in place for a week or ten days as a means of protecting the concrete until it becomes well set.

Piers should be allowed to set for at least two days before beginning the erection of the tower.

Method of Erection

The towers shown in the designs LX 24 and LX 25 and those of similar design are intended to be erected from the foundation, one piece at a time. The corner posts of the same cross section dimensions are exactly alike, and therefore are interchangeable. The splices in every case come just above the girts. This enables the erectors to lay planks across the girts on which to stand while the next section of the tower is built up. No support is required for the corner posts while the other parts are assembled. When the posts are bolted into position they stand securely until the girts and braces are added.

Within a week or two after the tower is completed all bolts and nuts should be gone over and made tight.

Damage by Snow

The members of base sections of steel towers located in regions where snow falls to depths ranging between ten and thirty feet are exposed to the probability of serious damage from the crushing force of settling snow. Two cases are of record where damage from this cause has necessitated the complete replacement of base sections. Where probability of damage from snow prevails, to avert it, protection structures of poles or sawed material should be constructed around the outside of the tower to the height of 16 feet. The structure should be in the form of a skeleton frame of stout members set on about 2-foot centers. The uprights should rest on sills at the bottom and should be well tied to plates on top.

Guying Towers

Some manufacturers warn against the guying of towers as an insurance against toppling. Notwithstanding this advice, experience proves the wisdom of guying towers over thirty feet high.

When guys are used, fasten one around each corner member at the topmost horizontal girt, and from that point extend them through turn-buckles to solid anchors located at least one-half the tower's height away from the tower's base. The anchors should be situated on a line which would exactly bisect diagonally the base of the tower through the corner posts.

Take up slack in the guys with the turnbuckles. Don't pull the guys too tight. Merely take up slack so that they will be taut during cold weather. During hot weather, due to expansion, the guys may be expected to be somewhat slack. Tightening the wires too much will develop strains in the steel structure. That must be avoided at all hazards.

Extra galvanized high strength steel strand 5-16-inch in diameter is recommended for guys. There will be needed for each guy eight 5/16-inch Crosby wire rope clips or four 5/16-inch three bolt strand clips, one 5/8-inch turnbuckle with eyes at both ends, and two 5/16-inch heavy thimbles.

All these findings should be heavily galvanized.

STEEL LOOKOUT TOWERS

Sample Specifications for Bids

Materials

All pieces shall be of the dimensions shown on the attached diagram. All pieces shall be straight and true, carefully cut to length and punched so that the tower can be put together without unnecessarily straining or distorting the material. The punched holes must be so accurately spaced that the tower will go together without the necessity of reaming the holes or of drifting and distorting the material. The punched holes shall not exceed the diameter of the bolt which it will accommodate by more than $1/32$ of an inch.

Galvanizing

After all the shop work has been finished, all structural parts of the tower must be thoroughly galvanized by using the hot process.

The galvanizing shall consist of a heavy coating of prime spelter. The spelter to be evenly and uniformly distributed over all surfaces of the angle members, ladder runs, and metal house parts. Spelter shall be applied in such manner that it will not peel off in transportation or in the course of erecting the tower.

The bolts and nuts are to be galvanized by the electric process, the work to be carefully done and the threads to be cleaned so that the nuts can be easily turned on the bolts.

All galvanizing excepting that of bolts and nuts may be subjected to the following tests:

A solution of sulphate of copper shall be made, using commercial copper sulphate crystals in water having a specific gravity of 1.185 at seventy (70) degrees Fahrenheit. The testing solution shall have a maximum temperature not exceeding seventy (70) degrees Fahrenheit or

a minimum temperature of not less than sixty (60) degrees Fahrenheit. A sample piece galvanized shall be immersed in a standard solution, as above described, for one minute, and then removed, immediately washed in water thoroughly and wiped dry. This process shall be repeated. If, after the fourth immersion, there shall be a copper-colored deposit on the sample, or if the zinc should be removed, the lot from which the sample was taken shall be rejected.

Marking

Each member shall be marked to indicate its position in the tower. The successful bidder will furnish a diagram of the tower which will show by the erection mark on the steel itself the position of each piece.

Preparation for Shipment

All members that form one tower are to be put up in bundles, the bundles to be tagged with the tower number and with the proper erection mark. The bolts are to be boxed so that one box contains all the bolts necessary to put one tower together with an excess allowance of 5 per cent.

Observatory

The observatory frame to be of steel angle. The observatory corners to be of projections of the corner members of the towers. The first joint in the corner members to be at least 6 feet below the floor line of the observatory. The flooring to be of one-inch material to be supplied by the purchaser, not by the bidder. The design of the tower shall provide means of fastening flooring in place, bidder to furnish

2.

Tower to be designed to a sustained vertical live load of 1,000 pounds; snow load of 25 pounds each square foot of roof surface.

Wind pressure to be calculated on the basis of a hundred mile gale.

No single section of the steel to exceed a maximum length of ? feet.#

The bidder to submit with his bid blueprints showing details of the design of the tower he proposes to furnish. Details to be shown are:

1. Dimensions and structural shapes of each piece of steel going into the tower.
2. Drilled holes for connections.
3. Detailed design of ladder and methods of attaching the ladder to the tower.
4. Detailed design of the observatory.
5. Detail of anchor on scale of not less than 1/2 to 1 foot.
6. Dimensions called for on Figure one.*
7. The successful bidder to assign part numbers of each piece of the tower and will show these part numbers on a blueprint of the drawing of an assembled tower. These blueprints to be furnished in duplicate for each tower purchased and to be forwarded to the purchaser on or before the date of the shipment of the towers.
8. Weight of each tower shall be shown on the blueprints.

Prices quoted should be f.o.b. factory. Bid should indicate the shipping point.

#If towers are to be placed on point to which transportation is difficult, state maximum length of 14 feet. If transportation does not represent a difficult problem, state maximum length of 14 to 20 feet.

*Drawing of figure one should accompany every bid.

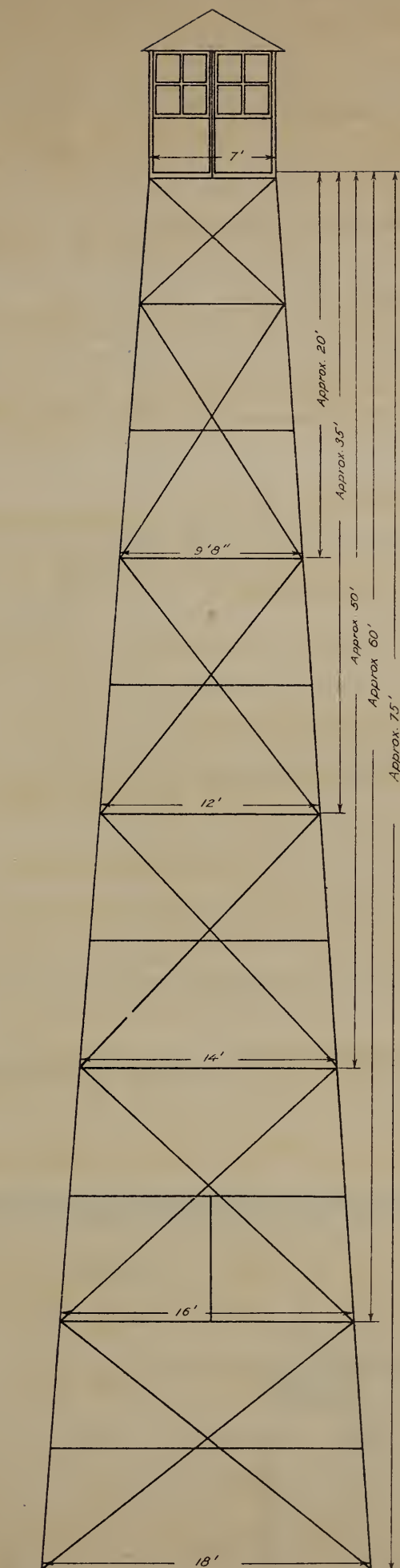
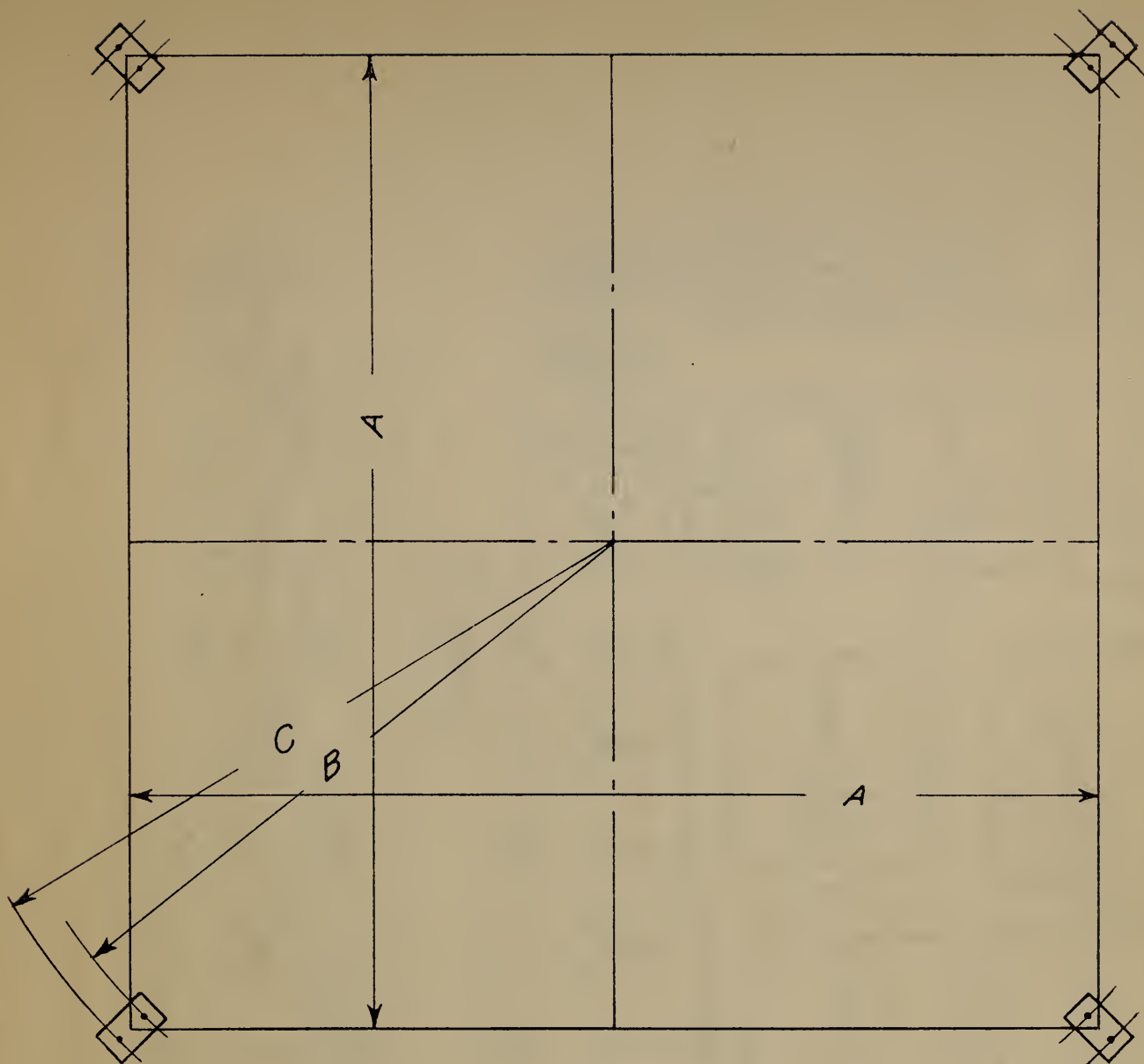


PLATE C. TO ACCOMPANY
SPECIFICATIONS TO MANUFACTURES



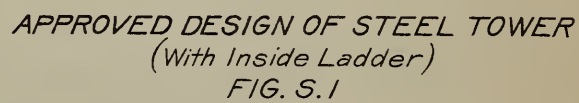
SETTING OF ANCHOR RODS



Fig. 1.

TABLE OF DIMENSIONS

HEIGHT TOWER	A	B	C	D	E	F

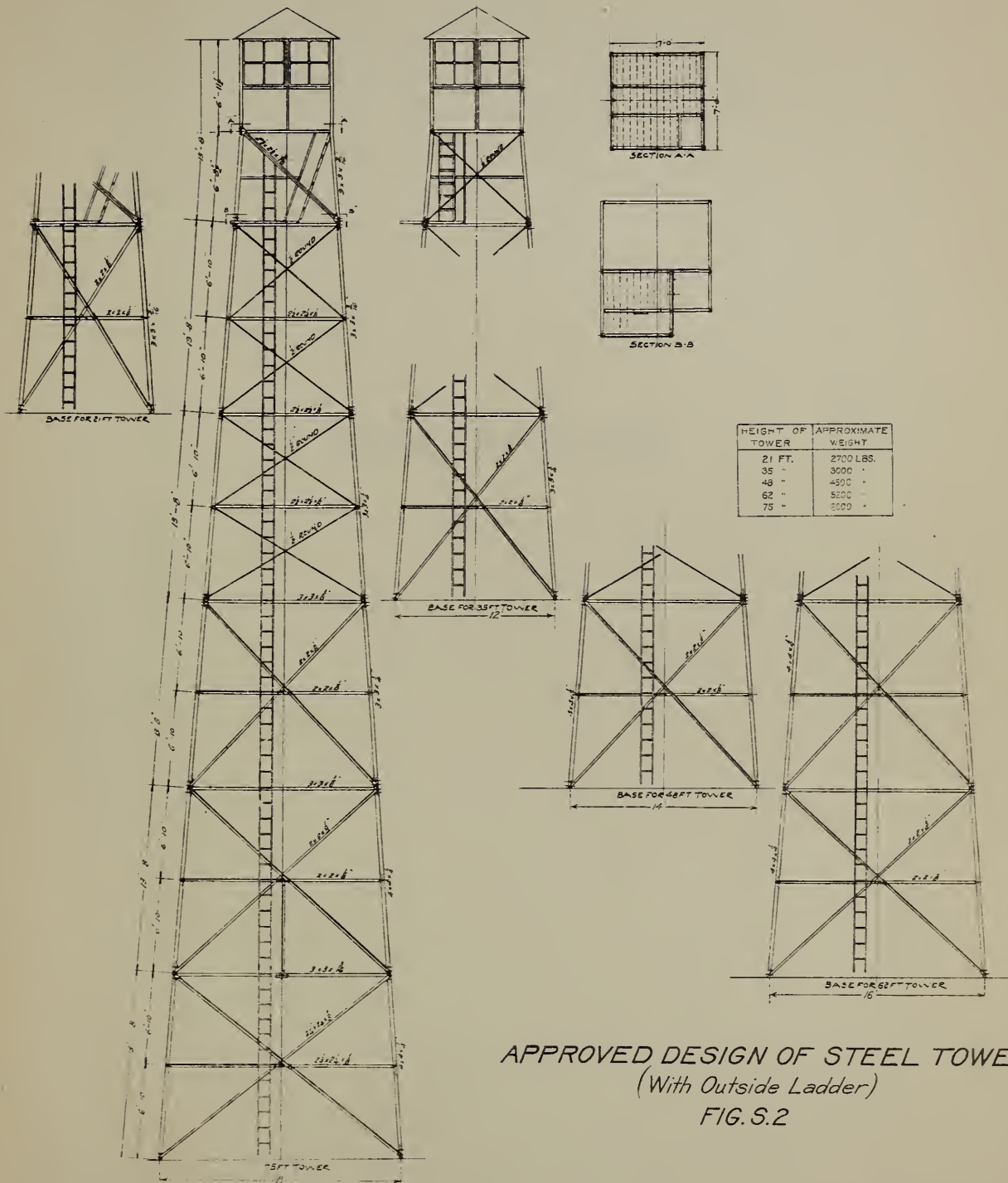


HEIGHT OF TOWER	APPROXIMATE WEIGHT
21 FT.	2800 LBS
35 "	4200 "
48 "	6300 "
62 "	8500 "
75 "	11000 "

AERMOTOR CO
FOREST SERVICE TOWERS
WITH INSIDE LADDER
SCALE $\frac{1}{4}$ "=1'-0"

CHICAGO
OCT. 16, '22

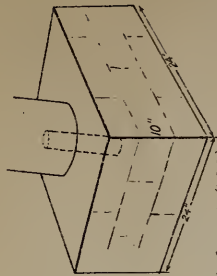




APPROVED DESIGN OF STEEL TOWER
(With Outside Ladder)
FIG. S.2

DESIGNS FOR POLE TOWERS

21



Block of concrete (1:2:3) or masonry set up with concrete reinforcement bars (rebar) for a tower structure. If suitable lumber is not available set out on "steep block" of concrete masonry or large hand stones. Stones should be perfectly solid and not less than 16" x 8". If tower is located on solid rock situation place the legs of tower directly on the natural foundation after preparing for the legs to rest in.

TOWER DIMENSIONS			
H	50'	40'	30'
R	14.5'	14.5'	15.5'
	14.5'	15.5'	17.0'

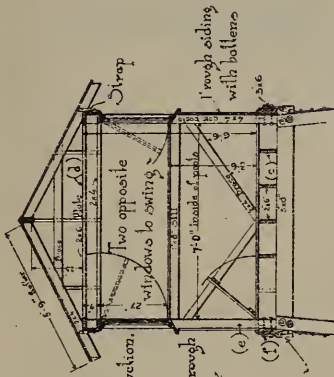
BILL OF MATERIAL	
a	2 pc 3" x 6" x 9' rough
b	2 pc 3" x 6" x 9'
c	16 pc 2" x 6" x 8'
d	4 pc 2" x 6" x 8'
e	16 pc 4" x 4" x 7'
f	16 pc 4" x 4" x 7'
g	16 pc 4" x 4" x 7'
h	16 pc 4" x 4" x 7'
i	16 pc 4" x 4" x 7'
j	16 pc 4" x 4" x 7'
k	16 pc 4" x 4" x 7'
l	16 pc 4" x 4" x 7'
m	16 pc 4" x 4" x 7'
n	16 pc 4" x 4" x 7'
o	16 pc 4" x 4" x 7'
p	16 pc 4" x 4" x 7'
q	16 pc 4" x 4" x 7'
r	16 pc 4" x 4" x 7'
s	16 pc 4" x 4" x 7'
t	16 pc 4" x 4" x 7'
u	16 pc 4" x 4" x 7'
v	16 pc 4" x 4" x 7'
w	16 pc 4" x 4" x 7'
x	16 pc 4" x 4" x 7'
y	16 pc 4" x 4" x 7'
z	16 pc 4" x 4" x 7'

...LOG LOOKOUT TOWER...

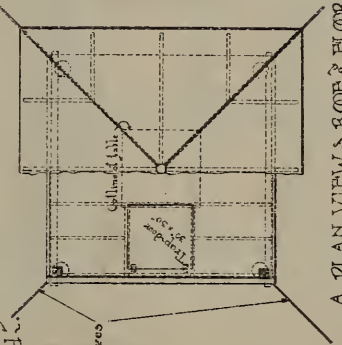
~ PIST. 3 ~

Scale 3/8" = 1' 1/2". Date ~ June 15, 1921.

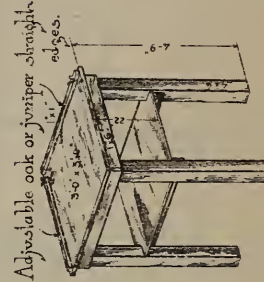
Drawn by J.M.M. Approved by C.A. Long.



SECTION & HOUSING



A PLAN VIEW & ROOF & FLOOR



PROTECTOR TABLE

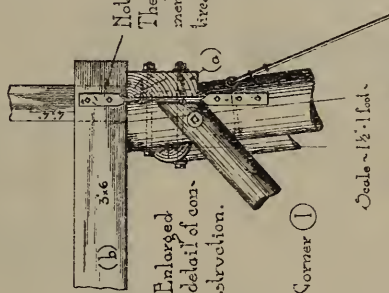
Scale 3/8" = 1' 1/2".

Roof 1/2 pitch pyramidal construction.

For housing use rough lumber wherever possible ~

Note skip iron ties. They are important members ~ Old wagon tires could be used ~

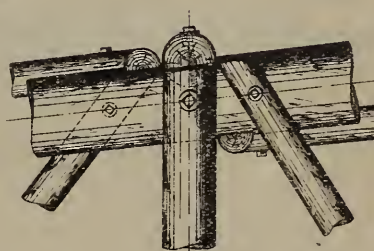
Guy-wires



Enlarged detail of construction.

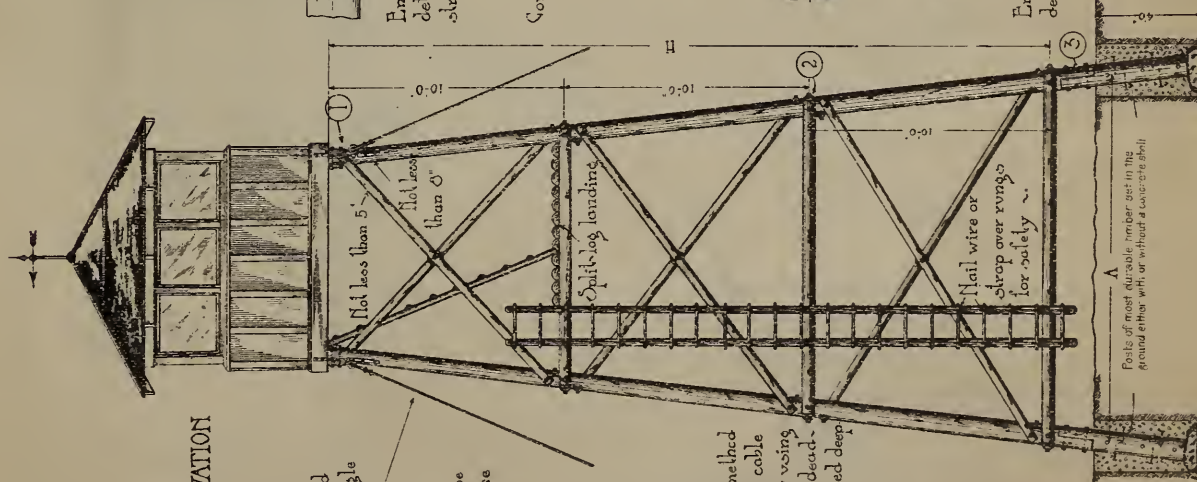
Corner 1

Scale 1/2" = 1' 1/2".



Enlarged ~ Corner 2 detail of construction ~

End posts, collar and sway braces must be of sound, straight native timber cut and fitted on the job ~



GENERAL VIEW & ELEVATION

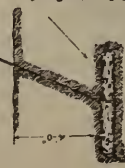
Guy-wire to be 3/8" wire strand with turn-buckle, set at an angle of 45° to structure ~

Length of splice to be not less than twice the diameter.

Scale 3/8" = 1' 1/2".



Showing method anchoring cable in earth by using good size dead-man buried deep



When surrounding material is solid rock this method is advised ~

Method of constructing footings for structure ~

Posts of most durable timber set in the ground either with or without a concrete shell

A

[illegible]